Appendix E
Research and Development

E-1. Introduction

a. General. A strong research and development effort is necessary to reduce the uncertainties still present in dam engineering. Few research projects to date, exceptions are in risk analysis and hydrologic design parameters, have been undertaken in the name of dam safety. Alternately, many research projects may provide a better understanding of site investigation and characterization, geotechnical and/or hydraulic considerations, construction methods, natural phenomenon and structural performance, all of which contribute to the safety of dams (Federal Emergency Management Agency 1979, Interagency Committee on Dam Safety Research Subcommittee 1982).

b. Definition. The Interagency Committee on Dam Safety (ICODS) Research Subcommittee has taken a liberal approach and defined dam safety research as that research which can help enhance the safety of dams (Interagency Committee on Dam Safety Research Subcommittee 1982).

c. Assessment of needs in dam safety research.

(1) Interagency Committee on Dam Safety Report. In 1980 the Research Subcommittee of ICODS was organized and charged to identify current dam safety research to develop a 5-year projection of research needs and to establish priorities for the research needs. In a report issued in May 1982, the Research Subcommittee, for the first time, presented consolidated information on research projects and needed dam safety research (Federal Emergency Management Agency 1982).

(2) Electric Power Research Institute and Federal Emergency Management Agency Workshop. A workshop on dam safety needs, sponsored by the Electric Power Research Institute (EPRI) and the Federal Emergency Management Agency (FEMA) was held in Denver, CO, in July 1985 to study research needs in dam safety. The workshop excluded seismic disturbance predictions and their influence on dam safety and hydrological considerations that would lead to predictions of the probable maximum flood that the dam might have to withstand because these topics had received extensive treatment in a previous study by the National Research Council of the National Academy of Sciences issued in March 1985 (National Research Council 1985).

(a) The most important needs for dam safety research identified by the workshop participants included (Karadi and Landis 1986) overtopping of dams (primarily earth and rock-fill dams), and the development of rational uplift criteria for concrete dams.

(b) Almost as much importance was placed on a second set of issues including development of a data base for earth and rock-fill dams and technology transfer, research on seepage and permeability as well as grouting, development of prediction techniques for inception and progression of erosion, evaluation of seismic behavior of concrete dams, and experimentation on natural and synthetic materials to define erosion and erosion control parameters.

d. Overview of dam safety research. The Government, industry and the academic community recognize the necessity for research in dam safety. During the 1980's numerous dam safety research was initiated to study problems such as spillway adequacy, foundation defects, and piping (Thomas 1987).

E-2. Dam Safety Research in the Corps of Engineers

a. Civil works program. The Corps of Engineers for many years has had an extensive research program seeking solutions to problems encountered in its civil works program for water resource development (Federal Emergency Management Agency 1988b).

b. Repair, Evaluation, Maintenance, and Rehabilitation Program. The Corps of Engineers has recently completed a 6-year major multidisciplinary research and development program entitled "Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Program." The primary objective of the REMR program was to identify and develop effective and

affordable technology for maintaining and extending the service life of existing Corps civil works structures. The REMR program covered a wide range of techniques for inspection, evaluation, repair, and rehabilitation of hydraulic structures including dams. Many of the research studies provide knowledge and techniques needed in many aspects of dam safety. An overview of the REMR program is available (U.S. Army Corps of Engineers 1990). A follow-on 7-year REMR-II program was started in Fiscal Year 1992 to address new and different needs identified by Corps field offices. Research conducted under REMR-II will have applicability to dam safety.

c. Dam Safety Risk Analysis Research Program. This program, conducted from 1984 to 1990, was managed by the Corps' Institute for Water Resources. The program consisted of numerous work units for dam safety risk analyses, including a work unit for hydrologic risk analyses conducted at the Corps' Hydrologic Engineering Center (Stakhiv and Moser 1986; Federal Emergency Management Agency 1988b; Duscha 1984, 1986; Von Thun 1984; Lave, Resendiz-Carrillo, and McMichael 1990). Studies of socioeconomic considerations and multiobjective risk partitioning in dam safety risk analysis were conducted (Cochrane, Ferrell-Dillard, Baumann 1987; Haimes et al. 1988).

E-3. Dam Safety Research by Other Federal Agencies

Significant effort goes into research on dam safety by other Federal agencies. General exchange of information and coordination of efforts are discussed in paragraph E-4.

a. Agencies. The agencies that manage the major part of Federal research and development activities related to dam safety (Federal Emergency Management Agency 1988b) are U.S. Army Corps of Engineers, Bureau of Reclamation, and Federal Emergency Management Agency.

b. Programs. Specialized research and development programs are conducted or sponsored by the Soil Conservation Service and the Electric Power Research Institute.

E-4. Coordination Among Federal Agencies

a. Technology. The technology for design, construction, operation, and maintenance of dams is constantly changing due to new developments from research; unique experience with projects under design, construction, or operation; new developments in laboratory testing and equipment and/or field investigation practices and procedures; and development of new analytical methods (U.S. Army Corps of Engineers, Office of the Chief of Engineers 1977; Federal Coordinating Council for Science, Engineering and Technology 1978).

b. Federal Agency exchange. Exchange of information and coordination of efforts on dam safety research among Federal agencies is accomplished through the ICODS Subcommittee on Safety Research and through the biennial Interagency Research Coordination Conferences (Federal Emergency Management Agency 1979, 1988b).

E-5. Transfer and Integration of New Technology

a. Transfer of new technology. There is no single, most successful, method of technology transfer. What works well for one type of technology and one type of user may not work as well for other users. Therefore, a successful technology transfer effort must use a combination of methods (U.S. Army Corps of Engineers 1990). Methods used to transfer dam safety technology include articles in technical journals, technical reports (written and/or video), information exchange bulletins, newsletters or technical notes, workshops and conferences, demonstrations of new technology on site, and electronic bulletin boards.

b. Integration of new technology. Various methods are used to integrate new technology into dam safety. Some of those methods are input to engineer manuals, engineer regulations, engineer technical letters, etc., PROSPECT course on dam safety, TADS program, training program for operations and maintenance personnel, use of experts or consultants, and computer data bases and expert systems.

U.S. Government Printing Office: 1996-412-340/50421